Exercise-1

✍ **Marked Questions can be used as Revision Questions.**

OBJECTIVE QUESTIONS

Section : (A) Work Done By Constant Force

A-1. If the unit of force and length each be increased by four times, then the unit of energy is increased by
(1) 16 times (2) 8 times (3) 2 times (4) 4 times

A-2. A man pushes wall and fails to displace it. He does
(1) Negative work (2) Positive but not maximum work
(3) No work at all (4) Maximum work

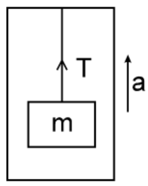
A-3. A rigid body moves a distance of 10 m along a straight line under the action of a force of 5 N. If the work done by this force on the body is 25 joules, the angle which the force makes with the direction of motion of the body is
(1) 0^o (2) 30^o (3) 60^o (4) 90^o

A-4. A rigid body of mass m kg is lifted uniformly by a man to a height of one metre in 30 sec. Another man lifts the same mass uniformly to the same height in 60 sec. The work done on the body against gravitation by them are in ratio
(1) 1 : 2 (2) 1 : 1 (3) 2 : 1 (4) 4 : 1

A-5. A particle moves from position $\vec{r_1} = 3\hat{i} + 2\hat{j} - 6\hat{k}$ to position $\vec{r_2} = 14\hat{i} + 13\hat{j} + 9\hat{k}$ under the action of force $4\hat{i} + \hat{j} + 3\hat{k}N$. The work done by this force will be
(1) 100 J (2) 50 J (3) 200 J (4) 75 J

A-6. A 50 kg man with 20 kg load on his head climbs up 20 steps of 0.25 m height each. The minimum work done by the man on the block during climbing is
(1) 5 J (2) 350 J (3) 1000 J (4) 3540 J

A-7.✍ A block of mass m is suspended by a light thread from an elevator. The elevator is accelerating upward with uniform acceleration a. The work done by tension on the block during t seconds is (u = 0) :



(1) $\frac{m}{2}(g + a)\, at^2$ (2) $\frac{m}{2}(g - a)at^2$ (3) $\frac{m}{2}gat^2$ (4) 0

Section (B) : Work Done by A Variable Force

B-1. A particle moves under the effect of a force F = Cx from x = 0 to x = x_1. The work done in the process is
(1) Cx_1^2 (2) $\frac{1}{2}Cx_1^2$ (3) Cx_1 (4) Zero

B-2. A force acting on a particle varies with the displacement x as $F = ax - bx^2$. Where a = 1 N/m and b = 1 N/m^2. The work done by this force for the first one meter (F is in newtons, x is in meters) is :
(1) $\frac{1}{6}$ J (2) $\frac{2}{6}$ J (3) $\frac{3}{6}$ J (4) None of these

B-3. Two springs have their force constant as k_1 and $k_2(k_1 > k_2)$. When they are stretched by the same force up to equilibrium -
(1) No work is done by this force in case of both the springs
(2) Equal work is done by this force in case of both the springs
(3) More work is done by this force in case of second spring
(4) More work is done by this force in case of first spring

B-4. A position dependent force $F = 7 - 2x + 3x^2$ newton acts on a small body of mass 2 kg and displaces it from x = 0 to x = 5m. The work done in joules is
(1) 70 (2) 270 (3) 35 (4) 135

B-5. A rigid body is acted upon by a horizontal force which is inversely proportional to the distance covered 's'. The work done by this force will be proportional to :
(1) s (2) s^2 (3) $\sqrt{s}$ (4) None of these

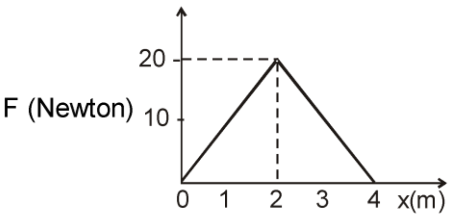
B-6. The work done by the frictional force on a surface in drawing a circle of radius r on the surface by a pencil of negligible mass with a normal pressing force N (coefficient of friction μ_k) is :
(1) $4\pi r^2 \mu_K N$ (2) $-2\pi r^2 \mu_K N$ (3) $-2\pi r \mu_K N$ (4) zero

Section (C) : Work Energy Theorem

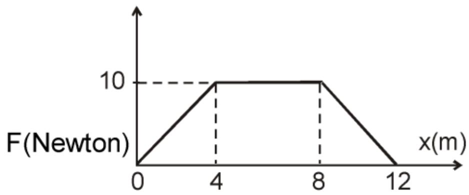
C-1. The kinetic energy of a body of mass 2 kg and momentum of 2 Ns is
(1) 1 J (2) 2J (3) 3 J (4) 4 J

C-2. A particle of mass m at rest is acted upon by a force F for a time t. Its kinetic energy after an interval t is :
(1) $\frac{F^2t^2}{m}$ (2) $\frac{F^2t^2}{2m}$ (3) $\frac{F^2t^2}{3m}$ (4) $\frac{Ft}{2m}$

C-3. The graph between the resistive force F acting on a body and the distance covered by the body is shown in the figure. The mass of the body is 25 kg and initial velocity is 2 m/s. When the distance covered by the body is 4m, its kinetic energy would be
(1) 50 J (2) 40 J
(3) 20 J (4) 10 J



C-4. A particle of mass 0.1 kg is subjected to a force which varies with distance as shown in figure. If it starts its journey from rest at x = 0, its velocity at x = 12 m is
(1) 0 m/s (2) $20\sqrt{2}$ m/s
(3) $20\sqrt{3}$ m/s (4) 40 m/s



C-5. A heavy stone is thrown from a cliff of height h with a speed v. The stone will hit the ground with maximum speed if it is thrown
(1) vertically downward (2) vertically upward

(3) horizontally (4) the speed does not depend on the initial direction.

C-6. The work done by all the forces (external and internal) on a system equals the change in
(1) total energy (2) kinetic energy (3) potential energy (4) none of these

C-7. A body starts from rest with uniform acceleration and acquires a velocity V in time T. The instantaneous kinetic energy of the body after any time t is proportional to :
(1) $(V/T)\,t$ (2) $(V^2/T)t^2$ (3) $(V^2/T^2)\,t$ (4) $(V^2/T^2)t^2$

C-8. If v, p and E denote the velocity, momentum and kinetic energy of the particle, then :
(1) $p = dE/dv$ (2) $p = dE/dt$ (3) $p = dv/dt$ (4) None of these

C-9. A retarding force is applied to stop a train. The train stops after 80 m. If the speed is doubled, then the distance travelled when same retarding force is applied is
(1) The same (2) Doubled (3) Halved (4) Four times

Section (D) : Mechanical Energy Conservation

D-1. The negative of the work done by the conservative internal forces on a system equals the change in
(1) total energy (2) kinetic energy (3) potential energy (4) none of these

D-2. A spring when stretched by 2 mm its potential energy becomes 4 J. If it is stretched by 10 mm, its potential energy is equal to
(1) 4 J (2) 54 J (3) 415 J (4) 100 J

D-3. A body is dropped from a certain height. When it loses U amount of its energy it acquires a velocity 'v'. The mass of the body is :
(1) $2U/v^2$ (2) $2v/U^2$ (3) $2v/U$ (4) $U^2/2v$

D-4. A stone projected vertically up with a velocity u reaches a maximum height h. When it is at a height of 3h/4 from the ground, the ratio of KE and PE at that point is : (consider PE = 0 at the point of projectory)
(1) 1 : 1 (2) 1 : 2 (3) 1 : 3 (4) 3 : 1

D-5. When a spring is stretched by 2 cm, it stores 100 J of energy. If it is stretched further by 2 cm, the stored energy will be increased by
(1) 100 J (2) 200 J (3) 300 J (4) 400 J

Section (E) : Power

E-1. The average power required to lift a 100 kg mass through a height of 50 metres in approximately 50 seconds would be
(1) 50 J/s (2) 5000 J/s (3) 100 J/s (4) 980 J/s

E-2. An electric motor creates a tension of 4500 N in hoisting cable and reels it at the rate of 2 m/s. What is the power of electric motor ?
(1) 9 W (2) 9 KW (3) 225 W (4) 9000 H.P.

E-3. A block of mass m is moving with a constant acceleration 'a' on a rough horizontal plane. If the coefficient of friction between the block and plane is μ.The power delivered by the external agent at a time t from the beginning is equal to :

(1) ma^2t (2) $\mu mgat$ (3) $\mu m(a + \mu g)\, gt$ (4) $m(a + \mu g)\, at$

E-4. A particle moves with a velocity $\vec{v} = (5\hat{i} - 3\hat{j} + 6\hat{k})$ m/s under the influence of a constant force $\vec{F} = (10\hat{i} + 10\hat{j} + 20\hat{k})$N. The instantaneous power applied to the particle is :

(1) 200 J/s (2) 40 J/s (3) 140 J/s (4) 170 J/s

E-5. A man M_1 of mass 80 kg runs up a staircase in 15 s. Another man M_2 also of mass 80 kg runs up the stair case in 20 s. The ratio of the power developed by them (P_1 / P_2) will be :

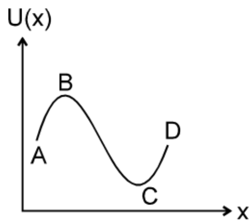
(1) 1 (2) 4/3 (3) 16/9 (4) None of the above

Section (F) : Conservative & Nonconservative Forces And Equilibrium

F-1. The potential energy of a particle in a field is $U = \frac{a}{r^2} - \frac{b}{r}$, where a and b are constant. The value of r in terms of a and b where force on the particle is zero will be :

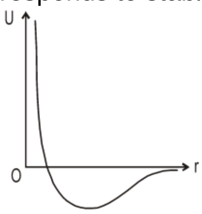
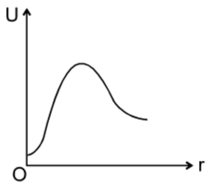
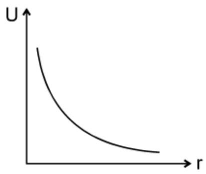
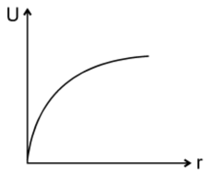
(1) $\frac{a}{b}$ (2) $\frac{b}{a}$ (3) $\frac{2a}{b}$ (4) $\frac{2b}{a}$

F-2. The potential energy of a particle varies with distance x as shown in the graph.The force acting on the particle is zero at



(1) C
(2) B
(3) B and C
(4) A and D.

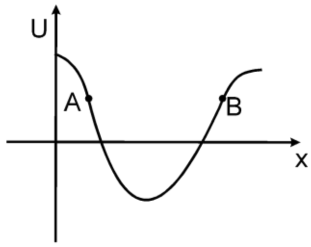
F-3. The diagrams represent the potential energy U of a function of the inter-atomic distance r. Which diagram corresponds to stable molecules found in nature.

(1) 
(2) 
(3) 
(4) 

F-4. The potential energy for a force field $\vec{F}$ is given by U(x, y) = sin (x + y). Magnitude of the force acting on the particle of mass m at $\left(0, \frac{\pi}{4}\right)$ is

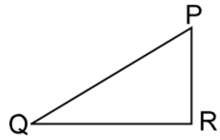
(1) 1 (2) $\sqrt{2}$ (3) $\frac{1}{\sqrt{2}}$ (4) 0

F-5. Potential energy v/s displacement curve for one dimensional conservative field is shown. Force at A and B is respectively.



(1) Positive, Positive
(2) Positive, Negative
(3) Negative, Positive
(4) Negative, Negative

F-6. For the path PQR in a conservative force field (fig.), the amount of work done in carrying a body from P to Q & from Q to R are 5 J & 2 J respectively . The work done in carrying the body from P to R will be –



(1) 7 J (2) 3 J
(3) $\sqrt{21}$ J (4) zero

Exercise-2

Marked Questions can be used as Revision Questions.

PART - I : OBJECTIVE QUESTIONS

1. The work done by the external forces on a system equals the change in
(1) total energy (2) kinetic energy (3) potential energy (4) none of these

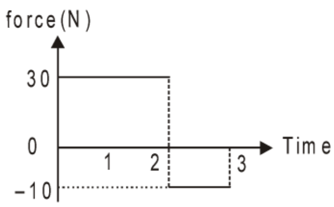
2. The total work done on a particle is equal to the change in its kinetic energy
(1) always (2) only if the forces acting on it are conservative
(3) only if gravitational force alone acts on it (4) only if elastic force alone acts on it.

3. An object is moving along a straight line path from P to Q under the action of a force $\vec{F} = (4\hat{i} - 3\hat{j} + 2\hat{k})$ N. If the co-ordinate of P & Q in metres are (3, 2, -1) & (2, -1, 4) respectively. Then the work done by the force is:
(1) - 15 J (2) + 15 J (3) 1015 J (4) $(4\hat{i} - 3\hat{j} + 2\hat{k})$

4. Work done by static friction on an object:
(1) may be positive (2) must be negative
(3) must be zero (4) none of these

5. A particle of mass m is moving with speed u. It is stopped by a force F in distance x . If the stopping force is 4F then :
(1)work done by stopping force in second case will be same as that in first case.
(2) work done by stopping force in second case will be 2 times of that in first case.
(3) work done by stopping force in second case will be 1/2 of that in first case.
(4) work done by stopping force in second case will be 1/4 of that in first case.

6. Starting at rest, a 10 kg object is acted upon by only one force as indicated in figure. Then the total work done by the force is



(1) 90 J
(2) 125 J
(3) 245 J
(4) 490 J

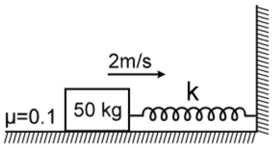
7. Select the correct alternative.
(1) Work done by kinetic friction on a body always results in a loss of its kinetic energy.
(2) Work done on a body, in the motion of that body over a closed loop is zero for every force in nature.
(3) Total mechanical energy of a system is always conserved no matter what type of internal and external forces on the body are present.

(4) When total work done by a conservative force on the system is positive then the potential energy associated with this force decreases.

8. The potential energy of a particle varies with x according to the relation $U(x) = x^2 - 4x$. The point x = 2 is a point of :

(1) stable equilibrium (2) unstable equilibrium
(3) neutral equilibrium (4) none of above

9. A block of mass 50 kg is projected horizontally on a rough horizontal floor. The coefficient of friction between the block and the floor is 0.1. The block strikes a light spring of stiffness k = 100 N/m with a velocity 2m/s. The maximum compression of the spring is :



(1) 1 m (2) 2 m (3) 3 m (4) 4 m

10. A rigid body of mass m is moving in a circle of radius r with a constant speed v. The force on the body is $\frac{mv^2}{r}$ and is directed towards the centre. What is the work done by this force in moving the body over half the cirumference of the circle.

(1) $\frac{mv^2}{\pi r^2}$ (2) Zero (3) $\frac{mv^2}{r^2}$ (4) $\frac{\pi r^2}{mv^2}$

11. You lift a suitcase from the floor and keep it on a table. The work done by you on the suitcase depends on

(1) the path taken by the suitcase (2) the time taken by you in doing so
(3) the weight of the suitcase (4) your weight.

12. The kinetic energy of a particle continuously increases with time

(1) the resultant force on the particle must be parallel to the velocity at all instants.
(2) the resultant force on the particle must be at an angle greater than 90° with the velocity all the time
(3) its height above the ground level must continuously decrease
(4) the magnitude of its linear momentum is increasing continuously

13. When work done by force of gravity is negative (Assume only gravitational force to be acting)

(1) KE increases (2) KE stays constant
(3) PE increases (4) PE stays constant

14. When total work done on a particle is positive

(1) KE remains constant (2) Momentum decreases
(3) KE decreases (4) KE increases

15. When a man walks on a horizontal surface with constant velocity, work done by

(1) friction is zero (2) contact force is non zero
(3) gravity is non zero (4) None of these

16. One of the forces acting on a particle is conservative then which of the following statement(s) are true about this conservative force

(1) Its work is non zero when the particle moves exactly once around any closed path.
(2) Its work equals the change in the kinetic energy of the particle
(3) Then that particular force must be constant.
(4) Its work depends on the end points of the motion, not on the path between.

17. There are two massless springs A and B of spring constant K_A and K_B respectively and $K_A > K_B$. If W_A and W_B be denoted as work done on A and work done on B respectively, then

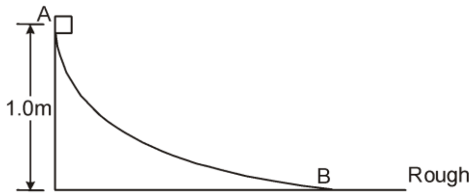
(1) If they are compressed to same distance, $W_A > W_B$

(2) If they are compressed by same force (upto equilibrium state) $W_A = W_B$

(3) If they are compressed by same distance, $W_A = W_B$

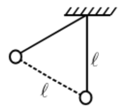
(4) If they are compressed by same force (upto equilibrium state) $W_A > W_B$

18. A block weighing 10 N travles down a smooth curved track AB joined to a rough horizontal surface (figure). The rough surface has a friction coefficient of 0.20 with the block. If the block starts slipping on the track from a point 1.0 m above the horizontal surface, the distance it will move on the rough surface is :



(1) 5.0 m (2) 10.0 m (3) 15.0 m (4) 20.0 m

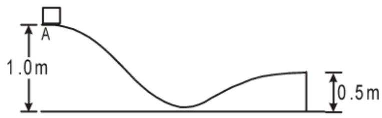
19. A bob hangs from a rigid support by an inextensible string of length ℓ. If it is displaced through a distance ℓ (from the lowest position) keeping the string straight & then released. The speed of the bob at the lowest position is :



(1) $\sqrt{g\ell}$ (2) $\sqrt{3g\ell}$

(3) $\sqrt{2g\ell}$ (4) $\sqrt{5g\ell}$

20. Figure shows a particle sliding on a frictionless track which terminates in a straight horizontal section. If the particle starts slipping from the point A, how far away from the track will the particle hit the ground ?



(1) At a horizontal distance of 1 m from the end of the track.

(2) At a horizontal distance of 2 m from the end of the track.

(3) At a horizontal distance of 3 m from the end of the track.

(4) Insufficient information

21. Two springs A and B ($k_A = 2k_B$) are strettched by applying forces of equal magnitudes at the four ends. If the energy stored in A is E, that in B is

(1) E/2 (2) 2E (3) E (4) E/4

PART - II : MISCELLANEOUS QUESTIONS

Section (A) : Assertion/Reasoning

A-1. **Statement -1 :** A person walking on a horizontal road with a load on his head does no work on the load against gravity.

Statement -2 : No work is said to be done, if directions of force and displacement of load are perpendicular to each other.

(1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(2) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Statement-1 is False, Statement-2 is True
(5) Both statements are false

A-2. **Statement-1 :** The instantaneous power of an agent is measured as the dot product of instantaneous velocity and the force (only one force applied by agent) acting on it at that instant.

Statement-2 : The unit of instantaneous power is watt.

(1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(2) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Statement-1 is False, Statement-2 is True
(5) Both statements are false

A-3. **Statement-1 :** Water at the foot of the water fall is always at different temperature from that at the top.

Statement-2 : The potential energy of water at the top is converted into heat energy (some or full part of energy) at the foot of the water fall.

(1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(2) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Statement-1 is False, Statement-2 is True
(5) Both statements are false

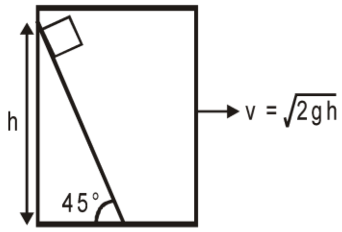
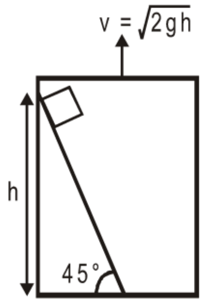
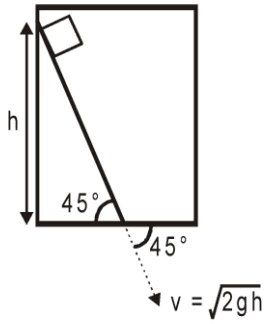
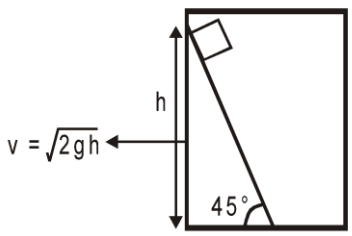
A-4. **Statement-1 :** Graph between potential energy of a spring versus the extension or compression of the spring is a straight line.

Statement-2 : Potential energy of a stretched or compressed spring is proportional to square of extension or compression.

(1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(2) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Statement-1 is False, Statement-2 is True
(5) Both statements are false

Section (B) : Match the column

B-1. Figure shows four situations in which a small block of mass 'm' is released from rest (with respect to smooth fixed wedge) as shown in figure. Column-II shows work done by normal reaction on the block (with respect to an observer who is stationary on ground) till block reaches at the bottom of inclined wedge, match the appropriate column.

Column–I		**Column–II**	
(1)		(p)	Positive
(2)		(q)	Negative
(3)		(r)	equal to mgh in magnitude
(4)		(s)	equal to zero

Section (C) : One or More Than One Options Correct

C-1. If the resultant force is always perpendicular to motion of a particle
(1) KE remains constant (2) work done = 0
(3) speed is constant (4) velocity is constant

C-2. Work done by force of friction

(1) can be zero (2) can be positive
(3) can be negative (4) information insufficient

C-3. When work done by force of gravity is negative (Assume only gravitational force to be acting)
(1) KE increases (2) KE decreases
(3) PE increases (4) PE stays constant

C-4. When total work done on a particle is positive
(1) KE remains constant (2) Momentum increases
(3) KE decreases (4) KE increases

C-5. When a man walks on a horizontal surface with constant velocity, work done by
(1) friction is zero (2) contact force is zero
(3) gravity is zero (4) None of these

C-6. A particle is taken from point A to point B under the influence of a force field. Now it is taken back from B to A and it is observed that the work done in taking the particle from A to B is not equal to the work done in taking it from B to A. If W_{nc} and W_c is the work done by non-conservative forces and conservative forces present in the system respectively, ΔU is the change in potential energy, Δk is the change in kinetic energy, then
(1) $W_{nc} - \Delta U = \Delta k$ (2) $W_c = -\Delta U$ (3) $W_{nc} + W_c = \Delta k$ (4) $W_{nc} - \Delta U = -\Delta k$

Exercise-3

PART - I : AIEEE PROBLEMS (PREVIOUS YEARS)

1. If a body loses half of its velocity on penetrating 3 cm in a wooden block, then how much will it penetrate more before coming to rest? **[AIEEE 2002, 4/300]**
(1) 1 cm (2) 2 cm (3) 3 cm (4) 4 cm

2. A spring of force constant 800 N/m has an extension of 5cm. The work done in extending it from 5cm to 15cm is **[AIEEE 2002, 4/300]**
(1) 16 J (2) 8 J (3) 32 J (4) 24 J

3. A spring of spring constant 5×10^3 N/m is stretched initially by 5 cm from the unstretched position. Then the work required to stretch it further by another 5 cm is : **[AIEEE 2003, 4/300]**
(1) 12.50 N-m (2) 18.75 N-m (3) 25.00 N-m (4) 6.25 N-m

4. A uniform chain of length 2 m is kept on a table such that a length of 60 cm hangs freely from the edge of the table. The total mass of the chain is 4 kg. What is the work done in pulling the entire chain on the table? **[AIEEE 2004, 4/300]**
(1) 7.2 J (2) 3.6 J (3) 120 J (4) 1200 J

5. A force $\vec{F} = (5\hat{i} + 3\hat{j} + 2\hat{k})$N is applied over a particle which displaces it from origin to the point $\vec{r} = (2\hat{i} - \hat{j})$m. The work done on the particle in joules is : **[AIEEE 2004, 4/300]**
(1) – 7 (2) + 7 (3) + 10 (4) + 13

6. A body of mass m is accelerated uniformly from rest to a speed v in a time T. The instantaneous power delivered to the body as a function of time, is given by : **[AIEEE 2005, 4/300]**
(1) $\frac{mv^2}{T^2}.t$ (2) $\frac{mv^2}{T^2}.t^2$ (3) $\frac{1}{2}\frac{mv^2}{T^2}.t$ (4) $\frac{1}{2}\frac{mv^2}{T^2}.t^2$

7. A particle of mass 100 g is thrown vertically upwards with a speed of 5 m/s. the work done by the force of gravity during the time the particle goes up is **[AIEEE 2006, 1.5/180]**

(1) – 0.5 J (2) –1.25 J (3) +1.25 J (4) 0.5 J

8. A ball of mass 0.2 kg is thrown vertically upwards by applying a force by hand. If the hand moves 0.2 m while applying the force and the ball goes upto 2 m height further, find the magnitude of the force. Consider $g = 10\ m/s^2$ **[AIEEE 2006, 3/180]**

(1) 22 N (2) 4 N (3) 16 N (4) 20 N

9. A particle is projected at 60º to the horizontal with a kinetic energy K. The kinetic energy at the highest point is

(1) K (2) zero (3) K/4 (4) K/2

10. An athlete in the olympic games covers a distance of 100 m in 10 s. His kinetic energy can be estimated to be in the range **[AIEEE 2008, 3/105]**

(1) 2×10^5 J – 3×10^5 J (2) 20,000 J – 50,000 J

(3) 2,000 J – 5,000 J (4) 200 J – 500 J

11. At time t = 0s a particle starts moving along the x-axis. If its kinetic energy increases uniformly with time 't', the net force acting on it must be proportional to : **[AIEEE 2011 (11-05-2011); 3/120, –1]**

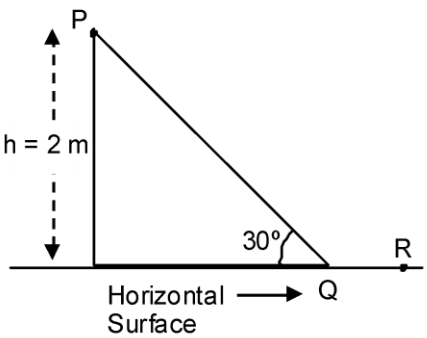
(1) constant (2) t (3) $\frac{1}{\sqrt{t}}$ (4) $\sqrt{t}$

12. When a rubber-band is stretched by a distance x, it exerts a restoring force of magnitude $F = ax + bx^2$ where a and b are constants. The work done in stretching the unstretched rubber-band by L is : **[JEE(Main)-2014; 3/120, –1]**

(1) $aL^2 + bL^3$ (2) $\frac{1}{2}(aL^2 + bL^3)$ (3) $\frac{aL^2}{2} + \frac{bL^3}{3}$ (4) $\frac{1}{2}\left(\frac{aL^2}{2} + \frac{bL^3}{3}\right)$

13. A point particle of mass m, moves along the uniformly rough track PQR as shown in the figure. The coefficient of friction, between the particle and the rough track equals μ. The particle is released, from rest, from the point P and it comes to rest at a point R. The energies, lost by the ball, over the parts, PQ and QR, of the track, are equal to each other, and no energy is lost when particle changes direction from PQ to QR.

The values of the coefficient of friction μ and the distance x(= QR), are, respectively close to : **[JEE Main 2016; 4/120, – 1]**



(1) 0.2 and 3.5 m (2) 0.29 and 3.5 m

(3) 0.29 and 6.5 m (4) 0.2 and 6.5 m

14. A person trying to lose weight by burning fat lifts a mass of 10 kg upto a height of 1 m 1000 times. Assume that the potential energy lost each time he lowers the mass is dissipated. How much fat will he use up considering the work done only when the weight is lifted up ? Fat supplies 3.8×10^7 J of energy per kg which is converted to mechanical energy with a 20% efficiency rate. Take $g = 9.8\ ms^{-2}$ **[JEE(Main)-2016; 4/120, – 1]**

(1) 6.45×10^{-3} kg (2) 9.89×10^{-3} kg

(3) 12.89×10^{-3} kg (4) 2.45×10^{-3} kg

15. A time dependent force F = 6t acts on a particle of mass 1kg. If the particle starts from rest, the work done by the force during the first 1 sec. will be :

(1) 18 J (2) 4.5 J (3) 22 J (4) 9 J

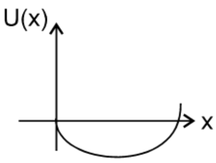
16. A body of mass $m = 10^{-2}$ kg is moving in a medium and experiences a frictional force $F = -kv^2$. Its initial speed is $v_0 = 10\ ms^{-1}$. If after 10 s, its energy is $\frac{1}{8}mv_0^2$,the value of k will be :
[JEE(Main)-2017; 4/120, –1]
(1) $10^{-1}Kg\ m^{-1}s^{-1}$ (2) $10^{-3}Kg\ m^{-1}$ (3) $10^{-3}Kg\ s^{-1}$ (4) $10^{-4}Kg\ m^{-1}$

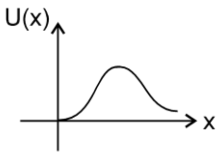
PART - II : JEE (ADVANCED) / IIT-JEE PROBLEMS (PREVIOUS YEARS)

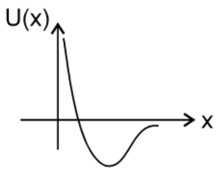
1. A force $\vec{F} = -K(y\hat{i} + x\hat{j})$ where K is a positive constant, acts on a particle moving in the x-y plane. Starting from the origin, the particle is taken along the positive x-axis to the point (a,0) and then parallel to the y-axis to the point (a,a). The total work done by the force $\vec{F}$ on the particle is
[JEE 1998; 3/60, –1]
(A) $-2Ka^2$ (B) $2Ka^2$ (C) $-Ka^2$ (D) Ka^2

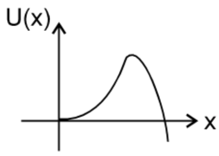
2. An ideal spring with spring-constant k is hung from the ceiling and a block of mass M is attached to its lower end. The mass is released with the spring initially unstreched. Then the maximum extension in the spring is **[JEE(Scr) 2002, 3/105]**
(A) 4 Mg/k (B) 2 Mg/k (C) Mg/k (D) Mg/2k

3. A particle, which is constrained to move along the x-axis, is subjected to a force in the same direction which varies with the distance x of the particle from the origin as $F(x) = -kx + ax^3$. Here k and a are positive constants. For $x \geq 0$, the functional form of the potential energy U(x) of the particle is
[JEE(Scr) 2002, 3/105]

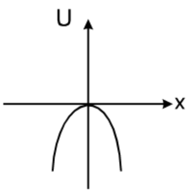
(A) 

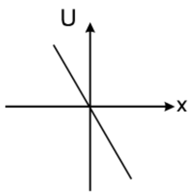
(B) 

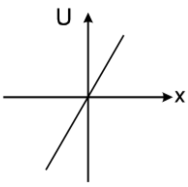
(C) 

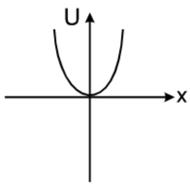
(D) 

4. A particle moves under the influence of a force F = kx in one dimensions (k is a positive constant and x is the distance of the particle from the origin). Assume that the potential energy of the particle at the origin is zero, the schematic diagram of the potential energy U as a function of x is given by
[JEE(Scr) 2004, 3/84]

(A) 

(B) 

(C) 

(D) 

5. **STATEMENT - 1 :** **[JEE 2007' 3/184]**

A block of mass m starts moving on a rough horizontal surface with a velocity v. It stops due to friction between the block and the surface after moving through a certain distance. The surface is now tilted to an angle of 30º with the horizontal and the same block is made to go up on the surface with the same initial velocity v. The decrease in the mechanical energy in the second situation is smaller than that in the first situation.

Because

STATEMENT - 2

The coefficient of friction between the block and the surface decreases with the increase in the angle of inclination.

(A) Statement-1 is True, Statement-2 is True; Statement-2 **is** a correct explanation for Statement-1

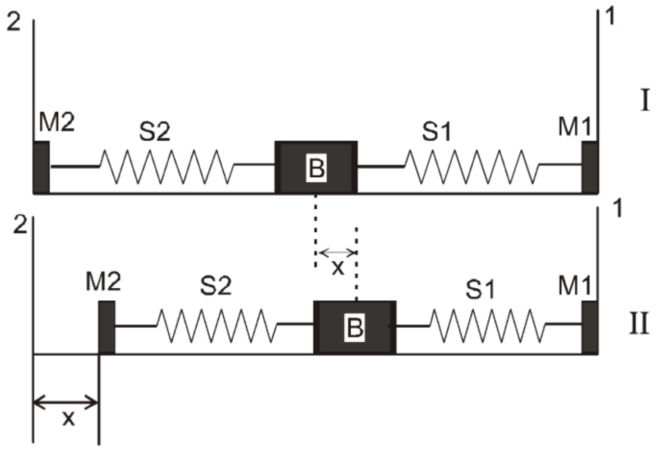
(B) Statement-1 is True, Statement-2 is True; Statement-2 **is NOT** a correct explanation for Statement-1

(C) Statement-1 is True, Statement-2 is False

(D) Statement-1 is False, Statement-2 is True.

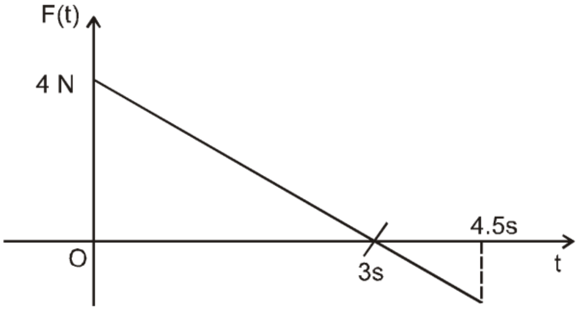
6. A block (B) is attached to two unstretched springs S1 and S2 with spring constants k and 4 k, respectively (see figure I). The other ends are attached to identical supports M1 and M2 not attached to the walls. The springs and supports have negligible mass. There is no friction anywhere. The block B is displaced towards wall 1 by a small distance x (figure II) and released. The block returns and moves a maximum distance y towards wall 2. Displacements x and y are measured with respect to the equilibrium position of the block B. The ratio $\frac{y}{x}$ is **[JEE 2008, 3/163]**

Figure :



(A) 4 (B) 2 (C) $\frac{1}{2}$ (D) $\frac{1}{4}$

7. A block of mass 2 kg is free to move along the x-axis. It is at rest and from t = 0 onwards it is subjected to a time-dependent force F (t) in the x direction. The force F (t) varies with t as shown in the figure. The kinetic energy of the block after 4.5 seconds is : **[JEE 2010; 5/160, –2]**



(A) 4.50 J (B) 7.50 J (C) 5.06 J (D) 14.06 J

8. The work done on a particle of mass m by a force, $K\left[\frac{x}{\left(x^2+y^2\right)^{3/2}}\hat{i}+\frac{y}{\left(x^2+y^2\right)^{3/2}}\hat{j}\right]$ (K being a constant of appropriate dimensions), when the particle is taken from the point (a, 0) to the point (0, a) along a circular path of radius a about the origin in the x-y plane is :

[JEE(Advanced)-2013; 3/60, –1]

(A) $\frac{2K\pi}{a}$ (B) $\frac{K\pi}{a}$ (C) $\frac{K\pi}{2a}$ (D) 0

Answers

EXERCISE – 1

Section : (A)

A-1.	(1)	**A-2.**	(3)	**A-3.**	(3)
A-4.	(2)	**A-5.**	(1)	**A-6.**	(3)
A-7.	(1)				

Section (B)

B-1.	(2)	**B-2.**	(1)	**B-3.**	(3)
B-4.	(4)	**B-5.**	(4)	**B-6.**	(4)

Section (C)

C-1.	(1)	**C-2.**	(2)	**C-3.**	(4)
C-4.	(4)	**C-5.**	(4)	**C-6.**	(2)
C-7.	(4)	**C-8.**	(1)	**C-9.**	(4)

Section (D)

D-1.	(3)	**D-2.**	(4)	**D-3.**	(1)
D-4.	(3)	**D-5.**	(3)		

Section (E)

E-1.	(4)	**E-2.**	(2)	**E-3.**	(4)
E-4.	(3)	**E-5.**	(2)		

Section (F)

F-1.	(3)	**F-2.**	(3)	**F-3.**	(1)
F-4.	(1)	**F-5.**	(2)	**F-6.**	(1)

EXERCISE – 2

PART - I

1.	(1)	**2.**	(1)	**3.**	(2)
4.	(1)	**5.**	(1)	**6.**	(2)
7.	(4)	**8.**	(1)	**9.**	(1)
10.	(2)	**11.**	(3)	**12.**	(4)
13.	(3)	**14.**	(4)	**15.**	(1)
16.	(4)	**17.**	(1)	**18.**	(1)
19.	(1)	**20.**	(1)	**21.**	(2)

PART – II

Section (A)

A-1.	(1)	**A-2.**	(2)	**A-3.**	(1)
A-4.	(4)				

Section (B)

B-1. (1→ p); (2 → p) ; (3 → s) ; (4 → q)

Section (C)

C-1.	(1,2,3)	**C-2.**	(1, 2 , 3)	**C-3.**	(2, 3)
C-4.	(2, 4)	**C-5.**	(1,2,3)		
C-6.	(1, 2, 3)				

EXERCISE – 3

PART - I

1.	(1)	**2.**	(2)	**3.**	(2)
4.	(2)	**5.**	(2)	**6.**	(1)
7.	(2)	**8.**	(1)	**9.**	(3)
10.	(3)	**11.**	(3)	**12.**	(3)
13.	(2)	**14.**	(3)	**15.**	(2)
10.	(4)				

PART - II

1.	(C)	**2.**	(B)	**3.**	(D)
4.	(A)	**5.**	(C)	**6.**	(C)
7.	(C)	**8.**	(D)		